SPECIAL PERMIT APPLICATION

EXHIBIT 18 - HYDROLOGIC ASSESSMENT

Hydrologic Assessment of Present and Proposed Future Use of the West Hawaii Concrete Quarry Site on TMK 6-8-01:66 in Waikoloa, Hawaii

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EXHIBIT 18

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Introduction

West Hawaii Concrete (WHC) seeks to amend its State Special Use Permit (SUP) to extend the life of the permit to run the quarrying operation to 2043 or longer, to add approval of its composting operation to the permit, and to enable processing and recycling of Portland cement concrete (PCC) and asphalt concrete pavement (ACP) on the site. Figure 1 shows the location of the 220-acre site off Waikoloa Road and abutting the boundary line between the South Kohala and North Kona districts.

This report has been prepared to support the amendment to the SUP. It presents a hydrologic assessment of the impact of present and planned activities on water resources. The assessment focuses on potential impacts to the underlying groundwater. Due to the topography, the existence of man-made berms, and the very high permeability of the surface lavas, it is not physically possible for surface runoff to leave the site.

Description of Present and Proposed Future Activities on the Site

Figure 2 shows the locations of present and proposed future activities on the 220-acre site. These are described and quantified below.

- Operation of the quarry began in 1995, about 20 years ago. Initially, the readily accessible surface material to a depth of approximately five feet was removed from most of the site. It was used for fill for various development projects in West Hawaii.
- At present, mining and processing to produce aggregate material is being done on about 25 acres toward the northwest corner of the site. Excavation is to a depth of 40 to 45 feet, the deepest it will go. In the future, mining activities would expand laterally to the south and/or west, excavating to the floor depth of the present pit. The mining operation is done with drilling and blasting, work which is presently done by Isemoto Contracting Co., Ltd under contract to WHC. Production in 2014 was about 32,800 tons of aggregate. This is the expectable rate of production going forward.
- A 3-acre site on prepared ground has been set aside for composting. Actual composting uses about two acres and was begun about five years ago. This work is done by a private contractor who brings the green waste to the site, operates the composting according to Department of Health (DOH) requirements, and sells the composted product.
- A site of about 10 acres has been prepared for the PCC and ACP processing and recycling. The raw PCC and ACP material to be processed and recycled would be stored in separate piles. When a sufficient volume of PCC or ACP has accumulated, a potable processing machine (or possibly a semi-permanent machine that would be removed at the termination of the quarry)

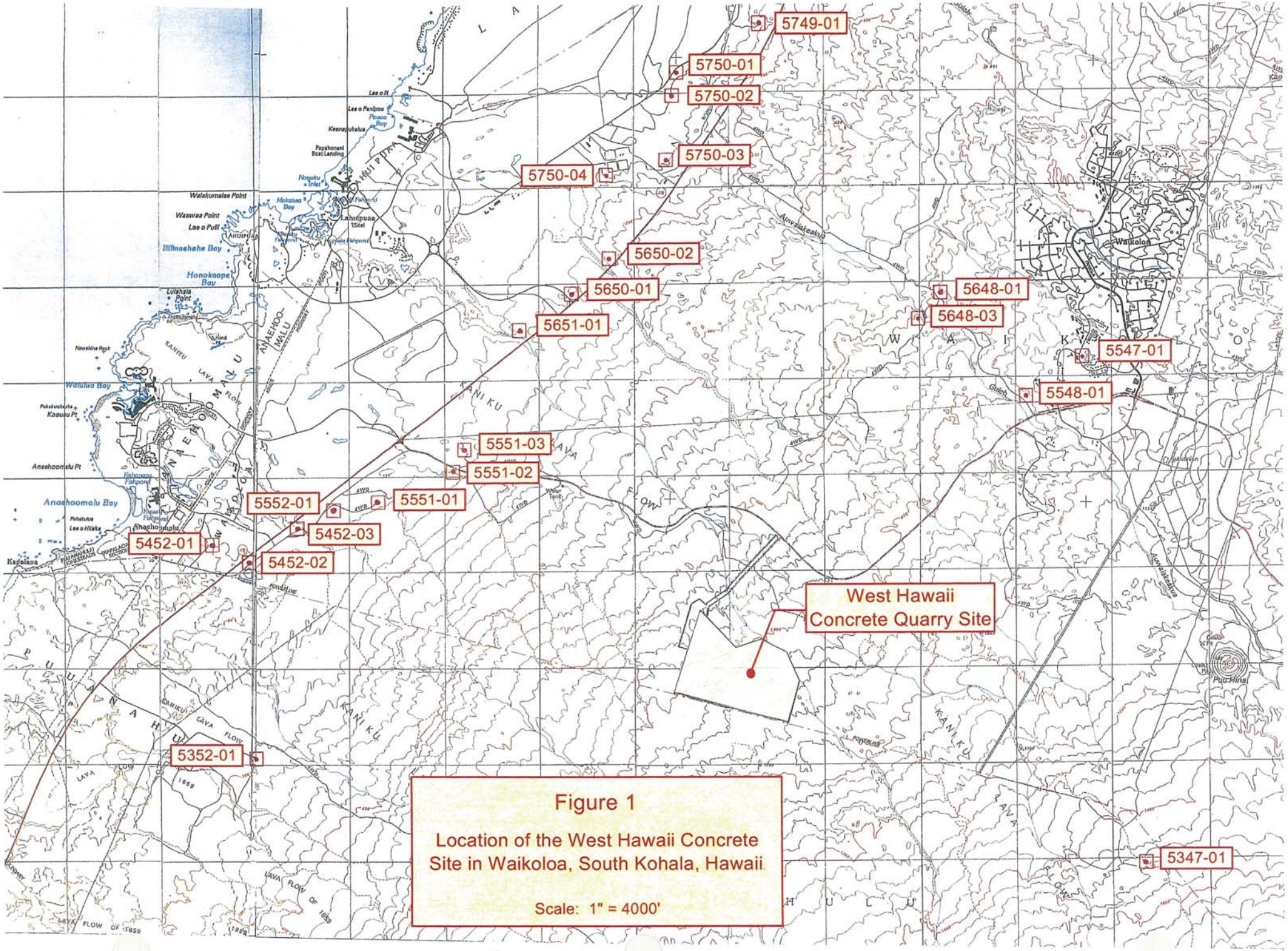
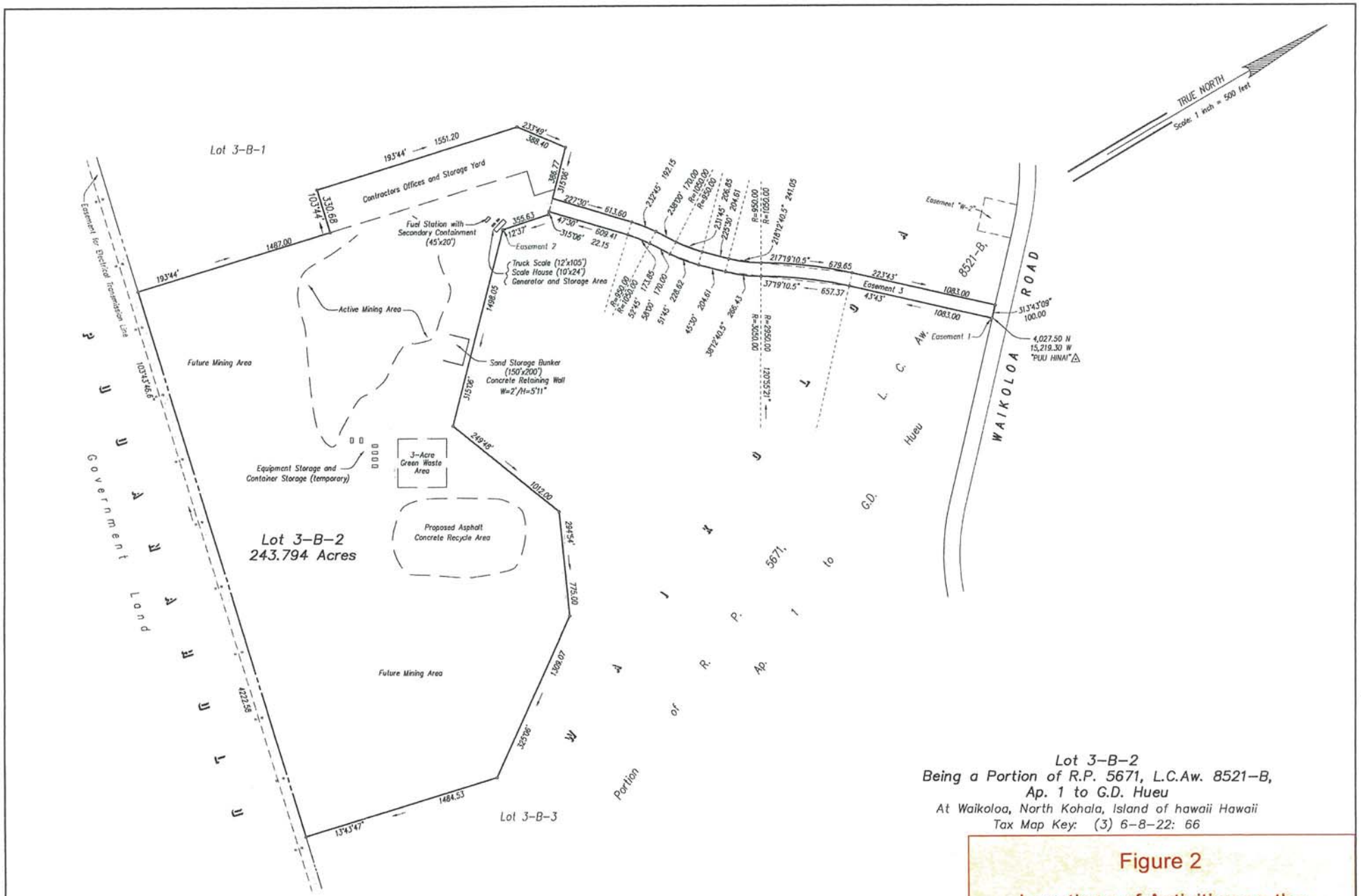


Figure 1

Location of the West Hawaii Concrete Site in Waikoloa, South Kohala, Hawaii.

Scale: 1" = 4000'



Lot 3-B-2
Being a Portion of R.P. 5671, L.C.Aw. 8521-B, Ap. 1 to G.D. Hueu
At Waikoloa, North Kohala, Island of hawaii Hawaii
Tax Map Key: (3) 6-8-22: 66

Figure 2

Locations of Activities on the West Hawaii Concrete Site

would be brought in. The finished product, typically ¾-inch minus for ACP or 2.5-inch minus for the PCC (after the rebar has been removed), would be stored onsite until sold or otherwise reused. Processing is not anticipated to be frequent. Depending on market conditions, it may be at three to eight year intervals.

- Water for use on the site is provided by the West Hawaii Water Company via a 4-inch pipeline alongside the access road to the quarry. Water use is limited to dust control during quarrying operations and to keep moisture in the compost pile as required by DOH. This use typically averages about 3300 gallons per day (GPD). It is expected to remain at about this level going forward except during the future infrequent processing of PCC and/or ACP, during which time the average annual use may be increased by about 10 percent.

Description of the Groundwater Beneath and in the General Vicinity of the West Hawaii Concrete Quarry Site

Groundwater Occurrence. Knowledge of groundwater conditions beneath and in the general vicinity of the project site comes primarily from wells that have been developed. Locations of some of these wells are shown on Figure 1 and information on them is compiled in Table 1. Groundwater beneath the site and encompassing the area from the shoreline for at least seven (7) miles inland occurs as a basal lens which floats on saline groundwater beneath it and shows level fluctuations in response to ocean tides and longer-tem mean ocean level changes. For about five miles inland, including directly beneath the quarry site, the groundwater is brackish but generally suitable for landscape irrigation of salt tolerant grasses and plants. The groundwater beneath the site stands about four (4) feet above sea level. Ground elevation at the quarry varies from 680 to 920 feet above sea level. The intervening lava between ground level and the groundwater below consists of numerous flows comprising what is known as the vadose (unsaturated) zone.

Groundwater Flowrate. The WHC quarry site is located in the Anaehoomalu Aquifer System as delineated by the State Commission on Water Resource Management (CWRM). At the quarry site, the delineated aquifer is 5.7 miles wide and the quarry is situated midway across that width. The CWRM has set the sustainable yield of the aquifer based on a calculated recharge of 69 million gallons per day (MGD) over its 291 square mile area (CWRM's 1990 Water Resources Protection Plan). That is equivalent to about five (5) inches per year or 22 percent of the rainfall on the aquifer's total area. Since there are no operating wells upgradient of the WHC quarry site, it also translates to a flow on the order of 12 MGD per mile of width beneath the quarry site.

A newer, more sophisticated, and presumably more accurate calculation of the aquifer's recharge is contained in "A Water Budget Model and Assessment of Groundwater Recharge for the Island of Hawaii" by J.A. Engott in 2011 (USGS Scientific Investigations Report 2011-5078). It puts the total

Table 1

Information on Wells in the General Vicinity of the West Hawaii Concrete Site

Well		Owner / Operator	Year Drilled	Ground Elevation (Feet MSL)	Total Depth (Feet)	Elevation at Bottom (Feet MSL)	Casing Diameter (Inches)	Installed Pump Capacity (GPM)	Representative Chlorides (MG/L)	Water Temperature (Deg. F.)	Distance Inland (Miles)	Present Use
State No.	Name											
5352-01	Landfill	Puuanahulu Landfill	1993	191	220	-29	8	100	950	72.0	1.82	Wash and Dust Control
5452-01	Nursery	West Hawaii Utility Co.	1980	40	43	-3	Dug Pit	900	890	74.1	0.56	Golf Course Irrigation
5452-02	51-Foot	West Hawaii Utility Co.	1980	51	53	-2	72	700	720	76.4	0.84	Golf Course Irrigation
5452-03	Irrigation No. 1	West Hawaii Utility Co.	1988	51	62	-11	12	350	690	76.6	1.11	Golf Course Irrigation
5551-01	Irrigation No. 3	West Hawaii Utility Co.	1990	92	110	-18	12	500	570	77.3	1.59	Golf Course Irrigation
5552-01	Irrigation No. 2	West Hawaii Utility Co.	1988	81	91	-10	12	700	665	75.3	1.31	Golf Course Irrigation
5551-02	Irrigation No. 4	West Hawaii Utility Co.	1991	95	114	-19	12	None	470	78.6	1.82	Not in Use
5551-03	Irrigation No. 5	West Hawaii Utility Co.	1991	126	141	-15	12	None	470	77.5	1.82	Not in Use
5651-01	Highway	Mauna Lani Resort	1988	121	130	-9	12	425	700	- -	1.61	Golf Course Irrigation
5650-01	Entrance	Mauna Lani Resort	1991	137	180	-43	8	250	950	82.6	1.65	Golf Course Irrigation
5650-02	Culvert	Mauna Lani Resort	1991	124	160	-36	12	350	950	- -	1.78	Golf Course Irrigation
5749-01	North	Mauna Lani Resort	1991	93	100	-7	12	450	580	- -	1.00	Golf Course Irrigation
5750-01	Puako Shaft	Mauna Lani Resort	1968 (e)	37	36	+1	Tunnel	880	700	- -	1.10	Golf Course Irrigation
5750-02	Puako 6	Mauna Lani Resort	Not Known	51	55	-4	66	150	650	- -	1.10	Golf Course Irrigation
5750-03	Fire Station	Mauna Lani Resort	1988	60	70	-10	12	425	825	- -	1.70	Golf Course Irrigation
5750-04	STP	Mauna Lani Resort	1989	55	70	-15	12	425	860	- -	1.48	Golf Course Irrigation
5648-01	Parker Test Hole	Waikoloa Water Co.	1968	620	651	-31	3	None	370	- -	3.70	Unused
5648-03	Aina Lea 1	Bridge Aina Lea	1992	598	637	-39	15	250	750	- -	3.69	Landscape Irrigation
5548-01	Parker 1	Waikoloa Village Owners Assoc.	1968	813	865	-52	12	350	600	82.6	4.47	Golf Course Irrigation
5547-01	WVA-1	Waikoloa Village Owners Assoc.	2007	935	975	-40	14	700	400	83.1	4.64	Golf Course Irrigation
5347-01	Puu Anahulu	State DLNR		1517	1548	-31	Uncased	None	60	86.0	6.94	Unused

Notes: 1. Information from the files of the State Commission on Water Resource Management.
2. Blanks in the table indicate that the information is not available.

recharge at 182 MGD or 2.6 times greater than the amount in the CWRM's 1990 WRPP. If correct, it would suggest a flowrate equivalent to 32 MGD per mile beneath the WHC quarry site.

In reality, based on the performance of wells downgradient of the WHC site (Figure 1 and Table 1), the one (unused) well 2.9 miles upgradient (State No. 5347-01), and numerous samplings of groundwater discharging along the aquifer's shoreline, the actual flowrate is significantly less than the amount in the CWRM's 1990 WRPP and far less than in the USGS water budget. Based on judgement and experience, the flowrate is no more than eight (8) MGD per mile of aquifer width, about two thirds of the amount in the 1990 WRPP and just one quarter of the calculated amount by the USGS.

Groundwater Quality. Table 2 is a compilation of water quality analyses of some of the wells that are nominally downgradient of the WHC quarry site. All of the sampled wells are actively used for golf course irrigation, are slightly brackish, and have nutrient levels indicative of naturally occurring groundwater quality. The reported salinity of Well 5347-01, which is 2.9 miles upgradient of the quarry site and 6.9 miles inland from the shoreline, is in the range of drinking water (chlorides of 60 milligrams per liter). Chlorides in groundwater directly beneath the WHC site are likely to be in the range of 250 to 350 MG/L.

Assessment of the Project's Present and Future Impact on Water Resources

As indicated previously, this assessment focuses exclusively on groundwater as the present and proposed future activities on the WHC site have no impact on surface water. As a matter of completeness, however, it should be noted that the USGS Puu Hinai quadrangle map shows a blue line indicating a surface water course passing along the north side of the quarry site with continuous definition to and through a large culvert in Queen Kaahumanu Highway. However, there is no field evidence anywhere along this delineated "water course" that it has ever carried surface runoff. Further, nothing at present or proposed for the WHC quarry site will change that.

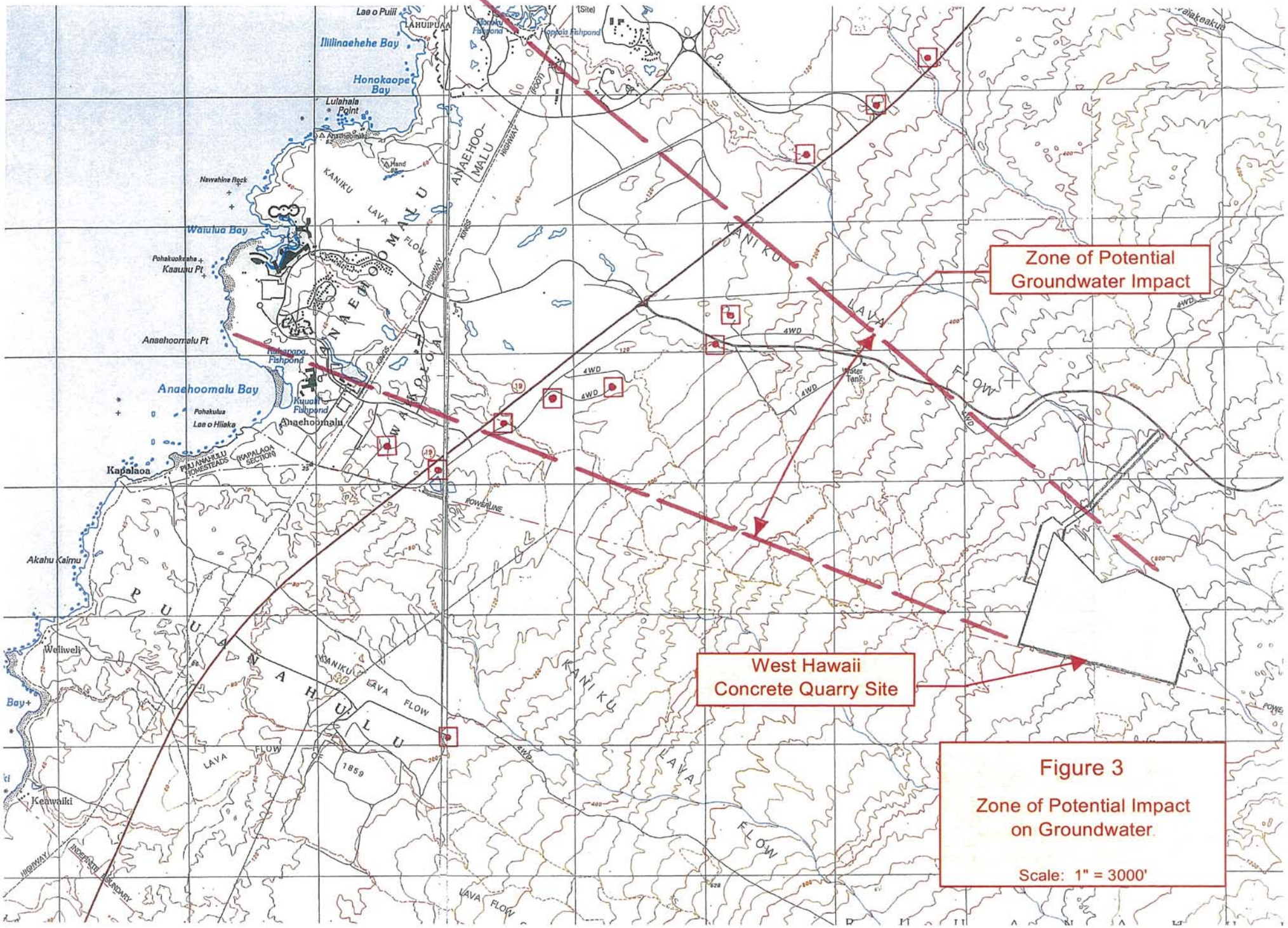
Area of Potential Impact on Groundwater. In the presumed mauka-to-makai direction of groundwater flow, the 220-acre WHC site has a width of 0.65 miles and a groundwater flow directly beneath it that is estimated to be on the order of five (5) MGD. If we allow a 10 degree span on either side of the presumed direction of groundwater flow, both to account for dispersion in groundwater and some uncertainty in the direction of groundwater flow, activities on the WHC site might conceivably impact the shoreline discharge of groundwater over a 1.9 mile wide section of the coastline from the north end of Anaehoomalu Bay to the south end of Makaiwa Bay (Figure 3). The present amount of shoreline groundwater discharge over this segment of the coast is estimated to be about 10 MGD (15 MGD of

Table 2

Quality of Groundwater in Wells Nominally Downgradient
of the West Hawaii Concrete Site

Well		Laboratory	Sample Date	NO_3 (µM)	NH_4 (µM)	DON (µM)	TN (µM)	PO_4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (PPT)
State No.	Name											
5452-01	Nursery	MAS	8-25-03	83.80	6.40	24.20	114.40	8.10	2.90	11.00	947	1.812
		U of W	10-21-05	52.32	2.64	35.34	90.30	1.76	2.58	4.34	857	1.704
		U of W	5-24-06	76.11	1.47	29.53	107.11	2.17	0.91	3.08	941	1.890
		U of W	8-30-06	47.81	1.82	67.41	117.04	1.81	2.52	4.33	883	1.680
		MAS	11-24-08	473.20	5.12	12.56	490.88	91.28	3.12	94.40	888	1.322
		MAS	12-12-08	315.00	6.20	5.80	327.00	81.70	0.50	82.20	826	1.405
		MAS	12-15-08	306.80	5.00	56.00	367.80	74.60	3.60	78.20	837	1.416
		MAS	2-28-15	55.60	1.05	2.00	58.65	3.25	0.00	3.25	772	1.960
			Averages	176.33	3.71	29.11	209.15	33.08	2.02	35.10	869	1.649
5452-02	51-Foot	MAS	8-25-03	254.10	11.20	22.40	287.70	51.10	3.20	54.30	959	1.841
		U of W	10-18-05	30.44	0.05	25.96	56.45	1.67	0.72	2.39	504	1.786
		U of W	5-24-06	54.12	0.12	56.47	110.71	1.89	1.80	3.69	874	1.742
		U of W	8-29-06	57.48	0.00	47.87	105.35	2.78	0.70	3.48	869	1.760
		MAS	11-24-08	700.16	20.64	4.10	724.90	151.20	0.40	151.60	769	0.764
		MAS	12-12-08	674.70	17.80	2.00	694.50	133.10	1.00	134.10	664	0.790
		MAS	12-15-08	337.00	1.00	53.40	391.40	59.20	1.80	61.00	765	1.607
		MAS	12-22-08	386.70	4.10	4.90	395.70	70.30	1.00	71.30	727	1.554
		MAS	2-28-15	63.15	0.80	2.10	66.05	3.85	0.25	4.10	765	1.832
			Averages	284.21	6.19	24.36	314.75	52.79	1.21	54.00	766	1.520
5452-03	WBR Irrigation 1	MAS	8-25-03	43.80	10.00	35.80	89.60	0.80	3.40	4.20	938	1.792
		U of W	10-18-05	41.85	1.09	44.96	87.90	3.22	3.97	7.19	851	1.393
		U of W	2-21-06	37.58	0.15	34.97	72.70	2.07	1.71	3.78	960	1.405
		U of W	5-24-06	46.04	0.09	39.59	85.72	1.62	1.34	2.96	875	1.377
		U of W	8-29-06	44.31	0.00	49.03	93.34	1.92	0.97	2.89	873	1.413
		MAS	11-24-08	52.96	5.60	22.00	80.56	1.52	1.44	2.96	847	1.765
		MAS	2-28-15	47.45	5.20	14.55	67.20	1.55	0.70	2.25	773	1.888
			Averages	44.86	3.16	34.41	82.43	1.81	1.93	3.75	874	1.58
5552-01	WBR Irrigation 2	MAS	8-25-03	45.70	7.00	25.80	78.50	0.50	3.00	3.50	936	1.736
		U of W	10-18-05	44.75	1.28	42.13	88.16	2.21	3.00	5.21	836	1.326
		U of W	2-21-06	41.14	0.11	43.81	85.06	1.74	2.14	3.88	966	1.315
		U of W	5-24-06	48.88	0.13	51.93	100.94	1.68	2.24	3.92	885	1.320
		U of W	8-29-06	46.27	0.07	45.01	91.35	1.78	1.16	2.94	870	1.351
		MAS	9-25-08	47.04	1.84	5.60	54.48	1.60	0.48	2.08	894	1.763
		MAS	11-28-08	43.80	3.40	13.30	60.50	2.00	0.70	2.70	845	1.752
		MAS	2-28-15	49.30	0.90	4.40	54.60	2.30	0.25	2.55	777	1.741
			Averages	45.86	1.84	29.00	76.70	1.73	1.62	3.35	876	1.54
5551-01	WBR Irrigation 3	MAS	8-25-03	45.40	6.00	26.10	77.50	1.40	2.40	3.80	966	1.488
		U of W	10-18-05	41.19	0.33	42.83	84.35	2.19	2.79	4.98	831	1.077
		U of W	5-24-06	44.49	0.12	31.33	75.94	1.61	0.53	2.14	879	1.119
		U of W	8-29-06	41.82	0.03	72.74	114.59	1.69	2.05	3.74	879	1.146
		MAS	9-25-08	41.20	0.40	6.08	47.68	1.44	0.56	2.00	879	1.483
		MAS	11-24-08	57.52	3.20	44.40	105.12	1.76	1.52	3.28	864	1.424
		MAS	2-28-15	47.40	1.25	7.35	56.00	2.05	0.05	2.10	786	1.495
			Averages	45.57	1.62	32.98	80.17	1.73	1.41	3.15	869	1.32
5551-03	WBR Irrigation 5	MAS	8-25-03	48.60	14.10	54.30	117.00	1.70	1.50	3.20	950	1.236
		MAS	11-28-08	45.70	4.80	0.40	50.90	3.60	0.20	3.80	855	1.187
			Averages	47.15	9.45	27.35	83.95	2.65	0.85	3.50	902	1.212
5352-01	West Hawaii Landfill	MAS	11-28-08	60.80	4.50	0.10	65.40	2.50	0.60	3.10	791	1.950

Notes: 1. All samples collected by Tom Nance of Tom Nance Water Resource Engineering.
2. MAS is Marine Analytical Specialists. U of W is the University of Washington.


Zone of Potential Groundwater Impact
West Hawaii Concrete Quarry Site
Lae o Puili
Ililinaehehe Bay
Honokaope Bay
Lulahala Point
Navahine Rock
Waiulua Bay
Kaauau Pt
Anaehoomalu Pt
Anaehoomalu Bay
Pohakulua
Lae o Hilaka
Kapalaoa
Akahu Kaimu
Weliweli
Keawaiki
KANIKU LAVA FLOW
ANAEHOOMALU
WAIKOLOA
PUUANAHULU
1859
POWERLINE
Figure 3
Zone of Potential Impact on Groundwater
Scale: 1" = 3000'

natural groundwater flow less about five MGD of ongoing pumping for golf course irrigation at the Waikoloa and Mauna Lani Resorts).

Potential Impact on Groundwater Flowrate and Shoreline Discharge. The WHC quarry's potential impact on groundwater flowrates is two fold. First, the water used at the WHC site comes from wells of the private West Hawaii Water Company. That system's seven active wells are to the northeast of the WHC site, in the Waimea Aquifer System, and span a 2.5-mile wide corridor in that aquifer. On an average annual basis, the pumpage of the private water company's drinking water wells is about 6.0 MGD and the use at the quarry site is 0.0033 MGD or 0.055 percent of that pumpage. Present uses for dust control in the actively mined quarry and for moisture control of the composting operation are not expected to change. The additions of the PCC and APC recycling operation will increase this by no more than 10 percent, bringing the project's site to no more than 0.06 percent of the well pumpage. The change is inconsequential, meaning that it is far too small to be detectable to have any impact on downstream use of the groundwater naturally flowing to and discharging along the Waimea Aquifer's shoreline.

The second potential impact is on the quantity of groundwater flowing directly beneath the WHC site (about five MGD) and/or on the 10 MGD ultimately discharging along the shoreline between Anaehoomalu and Makaiwa Bays. Present and potential onsite water use is in the range of 0.0033 to 0.0036 MGD. Conservatively, less than 10 percent of this or no more than 0.00033 to 0.00036 MGD percolates to the groundwater below. This would amount to an increase on the order of 0.006 to 0.007 percent to groundwater flowing beneath the site and far less than that to the groundwater discharging along the Anaehoomalu to Makaiwa shoreline. These are also inconsequential changes.

Potential Changes to Groundwater Quality. Present and future activities on the WHC quarry site that have the potential to impact groundwater quality include blasting in the quarrying operation, leachate from the composting operation, and refueling of equipment onsite. Explosives for quarrying that may impact groundwater are most easily identified as increases in nitrate and nitrite, but may also include volatile and semi-volatile organic compounds. Leachate from composting is likely to contain organic and inorganic nutrients (nitrogen and phosphorus) that are products of vegetative decomposition. Onsite fueling does occur, but it is done in a secondary containment area (45' x 20' in size). Its location is shown near the quarry entrance on Figure 2. Primary and secondary fuel containment effectively removes the possibility of a fuel spill impacting groundwater.

Blasting for the quarry operation is intermittent and percolate from compositing is in very small quantities, if at all. For these reasons it is not possible to accurately quantify the potential impact to groundwater quality. However, the following three aspects indicate that the possible adverse impacts are

minimal. First, the amount of water percolating to groundwater flowing beneath the site is very small. Impacts to quality would be diluted more than 15,000 fold in the receiving groundwater. Second, there is a substantial passage through the vadose zone (ie. the unsaturated lavas between the ground surface and the groundwater below) for percolate released from the site to reach the groundwater below (site elevating range from 680- to 920-foot elevations; the groundwater stands about four (4) feet above sea level). Vertical travel of the percolate through layers of unsaturated layers of lava removes and absorbs contaminants much like a trickling filter wastewater system. Third, decades of operation of the Grace Pacific quarry in Makakilo adjacent to the US Navy's drinking water skimming well (State No. 2103-03) with a potential for groundwater contamination orders of magnitude greater than at the WHC site, has not resulted in an adverse impact to the drinking water supply for the Navy's Barbers Point facilities.

Based on the foregoing analysis, it is reasonable to conclude that continuation of the quarrying operation, the composting, and the intermittent processing of PCC and ACP for recycling will have no detectable or actual significant impact on the underlying groundwater.